Performance Report:
NxtGen ECS

Performance Analysis of Virtual Machines on NxtGen ECS and Competitive IaaS Offerings

An Examination of Web Server and Database Workloads

April 2015

EXECUTIVE SUMMARY

NxtGen commissioned this benchmarking analysis to examine the relative performance of major VM components including virtual cores, memory, block storage, and internal network for NxtGen Enterprise Cloud Services (ECS), Amazon Web Services (AWS), and Rackspace Cloud Servers. Specifically, the study examines raw performance and price-indexed performance for two common workloads: web servers and databases. Findings from the study show that NxtGen ECS provides competitive levels of raw performance and price-indexed performance. NxtGen displayed particularly strong price-performance value, providing the most value across all five use cases examined in the study.

For this study, Cloud Spectator evaluated performance by benchmarking the VMs using Geekbench 3, FIO and Iperf. The respective benchmarks measured vCPU & Memory, Storage and Internal Network. Testing occurred over the course of a 5-day period. Pricing was examined in conjunction with the performance tests.

Performance & Price-Performance Key Findings:

- For the majority of tests, NxtGen exhibited the highest storage and internal network performance; Rackspace exhibited the highest vCPU and memory performance.
- NxtGen exhibited the highest price-performance value across all tests and workload scenarios.

INTRODUCTION

The rise of public cloud as a robust infrastructure choice over the past several years has led certain organizations to aggressively outsource their compute, memory, and storage needs to a growing number of IaaS providers. With increasing cloud adoption, more vendors have decided to enter this fast-growing market. Cloud Spectator's provider database contains 241 public cloud providers selling IaaS services across the world. With pricing levels, pricing structures, feature sets and performance patterns varying across every one of these providers, the number of variables at play is enormous. This diversity, while enhancing choice and market competition, has led to confusion among infrastructure buyers as to how to best assess cloud providers when making purchase decisions. Like-for-like performance assessments are particularly difficult when considering price and specific application use cases. To assess relative value for IaaS buyers, this Cloud Spectator study provides a normalized comparison of three cloud providers' services from Amazon, NxtGen and Rackspace. This analysis considers each provider's price and performance levels in the context of two common use cases.

METHODOLOGY

Cloud Spectator tested virtual machines from Amazon, NxtGen, and Rackspace for a period of five days between March 17, 2015 and March 21, 2015. One iteration of the test suite was run per day. Each iteration captured performance data on virtual processors, memory bandwidth, block storage IOPS, and internal network throughput. Block storage was tested instead of local, ephemeral storage because of its persistence, resiliency and dependability. Tests within the suite are categorized in the table below.

Test	Resources Measured	Description
Geekbench 3	Processor & Memory	Geekbench 3 is a licensable product designed by Primate Labs. It is a collection of tests designed to simulate real-world scenarios, providing an indication of processor and memory performance. Tests results are broken out between processor (integer & floating point) and memory scores.
Fio	Block Storage	Fio is an open source tool designed to stress IO. Cloud Spectator configured Fio to run sequential read, sequential write, random read, and random write tests to gather performance data on block storage IOPS.
Iperf	Network Throughput	Iperf is an open source tool used to measure network throughput between client and server. By default, Iperf connects between the machines and measures throughput performance using a TCP protocol. Cloud Spectator used the default TCP protocol and transferred data bi-directionally.

Table 1: The tests listed in this table were used to collect quantitative data on performance across the selected VMs (see Table 2) on all the providers examined in the study.

In an effort to standardize VM sizes between the providers, comparable virtual machine sizes were chosen based on equivalent amounts of virtual cores reported by the provider. Block storage was matched by comparing a 100GB, 500GB or 1000GB volume attached to each VM. A separate, equivalently sized virtual machine was provisioned within the same region/availability zone to act as a server for internal network testing. All virtual machines ran using Ubuntu Linux 14.04. The c4 instance type was selected for the Amazon 2vCPU VM comparison despite offering more memory than the comparable VMs on the other providers. At the time of the study, the c4 instances were the closest match to the other two providers' VM sizes. The amount of memory of the c4 instances did not significantly affect the memory bandwidth performance. Amazon and Rackspace machines were provisioned in data centers as close to NxtGen's Bangalore data center as possible. Table 2 provides details of VMs used for each provider.

2 vCPU Machines	vCPUs	Memory	Block Storage
Amazon c4.large	2	3.75GB	100GB
NxtGen ECS	2	2GB	100GB
Rackspace General1-2	2	2GB	100GB

4 vCPU Machines	vCPUs	Memory	Block Storage
Amazon m3.xlarge	4	15GB	500GB
NxtGen ECS	4	15GB	500GB
Rackspace I/O1-15	4	15GB	500GB

8 vCPU Machines	vCPUs	Memory	Block Storage
Amazon m3.2xlarge	8	30GB	1000GB
NxtGen ECS	8	30GB	1000GB
Rackspace I/O1-30	8	30GB	1000GB

Table 2: illustrates the VMs that were used in the comparison standardized by vCPU cores.
*Note: Amazon Block Storage testing examined EBS General Purpose (SSD) volumes; Rackspace Block Storage testing examined the Cloud Block Storage SSD volumes; NxtGen Block Storage testing examined the SSD Storage volumes

The CloudSpecs Score, which is an indexed score for price-performance value, was calculated by taking the monthly price of each server size and performance results of the components and using a formula to find the level of performance per unit of price. The resulting number was then pegged to the highest result for that server class, which gets a score of 100; thus, value numbers are relative.

For example, if Provider A scores 100 and Provider B scores 50, then Provider A shows 2x more price-performance value than Provider B. Please see the formula below to calculate the CloudSpecs Score.

1. provider_value = {provider performance score} / {provider cost}
2. best_provider_value = max{provider_values}
3. Provider's CloudSpecs Score = 100*provider_value / best_provider_value

Provider	Data Center	2 vCPU	4 vCPU	8 vCPU	100GB HDD	500GB HDD	1000GB HDD
Amazon EC2	Singapore	$110.96	$286.16	$572.32	$12.00	$60.00	$120.00
NxtGen ECS	Bangalore	$43.75	$146.05	$268.30	$14.48	$72.38	$144.77
Rackspace Cloud Server	Hong Kong	$65.70	$492.75	$985.50	$54.97	$274.85	$549.69

Table 3: The table above shows the price of the VMs used on the three providers. Rackspace pricing incorporates the required service fee at the Managed Infrastructure level. For providers with hourly pricing, usage of 730 hours per month was assumed in the monthly pricing above.

A CloudSpecs score was produced for each of the following components on all the providers: vCPU, memory, sequential/random read/write IOPS, and internal network (see Table 4). The separate scores were aggregated based on the relevant components examined in each category to produce a VM CloudSpecs Score for each virtual machine size. The VM CloudSpecs scores were then averaged to produce the Category's CloudSpecs Score. For example, on the Static Web Server:

1. VM CloudSpecs Score = ({vcpu_cloudspecs_score} + {read_iops_cloudspecs_score})/2
2. Static Web Server CloudSpecs Score = ({2vcpu_VM_CloudSpecs_Score} + {4vcpu_VM_CloudSpecs_Score})/2

Multi-core vCPU | CloudSpecs Scores	2 vCPU	4 vCPU	8 vCPU
Amazon EC2	52	74	80
NxtGen ECS	100	100	100
Rackspace Cloud Server	57	44	47

Memory Bandwidth | CloudSpecs Scores	2 vCPU	4 vCPU	8 vCPU
Amazon EC2	38	59	51
NxtGen ECS	100	100	100
Rackspace Cloud Server	43	38	41

Internal Network Throughput | CloudSpecs Scores	2 vCPU	4 vCPU	8 vCPU
Amazon EC2	15	37	36
NxtGen ECS	100	100	100
Rackspace Cloud Server	10	20	34

Block Storage Read IOPS | CloudSpecs Scores	2 vCPU	4 vCPU	8 vCPU
Amazon EC2 – General SSD EBS	7	7	6
NxtGen ECS – SSD	100	100	100
Rackspace Cloud Block Storage	30	13	12

Block Storage Write IOPS | CloudSpecs Scores	2 vCPU	4 vCPU	8 vCPU
Amazon EC2 – General SSD EBS	5	7	6
NxtGen ECS – SSD	100	100	100
Rackspace Cloud Block Storage	32	17	15

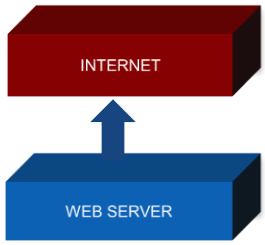
Table 4: A table listing the CloudSpecs scores received by NxtGen ECS VMs and their counterparts.

WEB SERVERS: VALUE COMPARISON

NxtGen's web server performance was examined in three categories: (1) static web server, which includes small websites; (2) read/write web server, which covers a majority of websites that users can download and upload content from/to; and (3) high-traffic web server, which encompasses large web architectures that sustain high amounts of traffic and transactions.

Both 2 vCPU and 4 vCPU virtual machines were used for the performance comparison of the web servers (see Methodology for more information). NxtGen ECS VMs did not exhibit the highest performance on all the tests conducted for processor performance, disk IOPS, and internal network throughput relative to their counterparts. However, factoring in the price of its services, the resulting price-performance value of NxtGen for the web servers was highest of all three providers, as shown in the value chart below.

STATIC WEB SERVER RESULTS



A static web server primarily serves content to viewers. Writes to the disk are commonly limited to any edits to the website made by the site administrator. Examples include personal webpages, online portfolios, and image galleries. The following performance metrics are considered for the static web server:

VIRTUAL PROCESSORS | READ IOPS

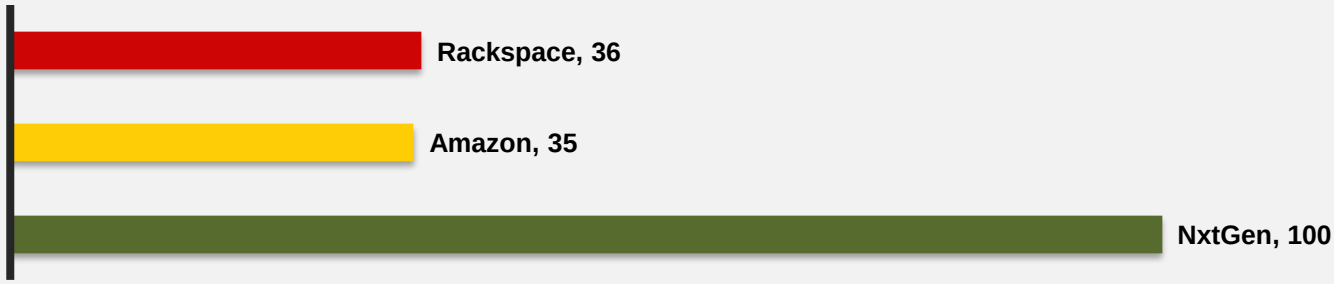
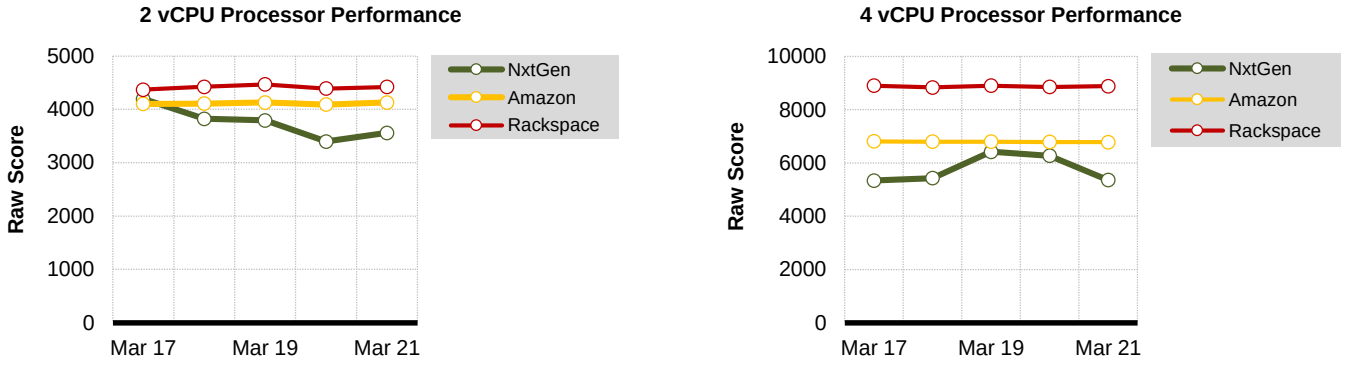


Chart 1: When examining virtual processor and block storage read performance in conjunction with cost to produce a value score, NxtGen demonstrated the highest value on its VMs as compared with its counterparts.

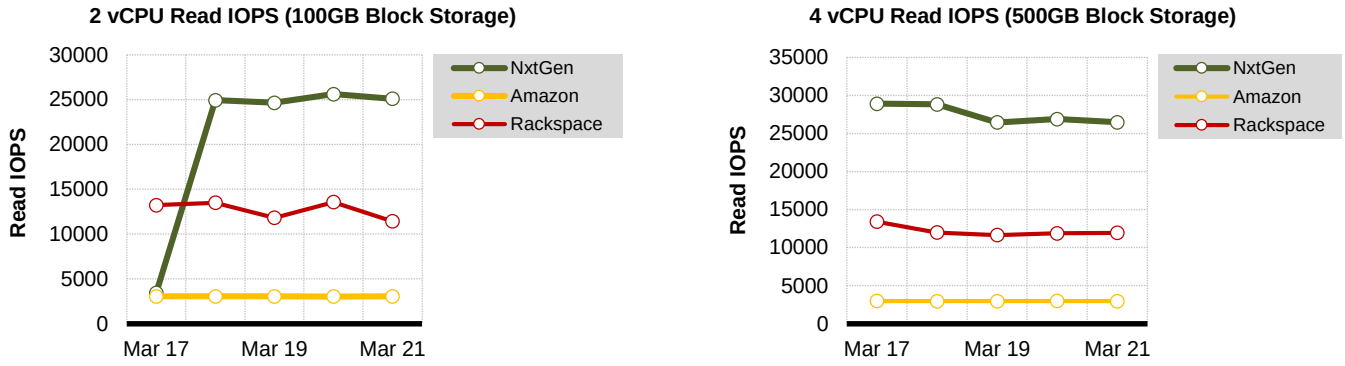
Chart 1 displays the differences in value between NxtGen's and the other providers' tested VMs for static web server use cases. NxtGen ECS achieved the highest composite value of the three providers examined. While NxtGen's processor performance exhibited varying comparative performance between 2 vCPU and 4 vCPU VMs, its strong block storage read IOPS and competitive pricing contributes to the high composite score.

On 2 vCPU and 4vCPU VMs Rackspace achieved the highest processor performance. Rackspace scaled linearly in processor performance corresponding to the number of vCPUs. Amazon scaled at a slightly lower ratio, while NxtGen had the lowest gain in performance when scaling up to 4vCPU (see Graph 1). Processor performance was examined by running Geekbench 3's sequential series of CPU-bound tasks such as data encryption, image compression/decompression and the BlackScholes options trading algorithm.

NxtGen ECS's disk reads from 100GB and 500GB block storage devices offered the highest performance of the three providers examined (see Graph 2). The IOPS numbers were acquired by running 50% sequential and 50% random read operations. NxtGen ECS's fast read speeds, coupled with a lower cost for block storage, resulted in a relatively lower cost per read transaction than its counterparts.

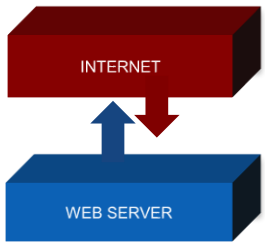


Graph 1: The processor performance over five days of the study (illustrated in the graphs) shows Rackspace leading in performance for both the 2vCPU and 4vCPU VMs.



Graph 2: Read performance examined in this study is comprised of 50% sequential reads and 50% random reads. NxtGen was able to sustain the highest performance across the 2vCPU and 4vCPU VMs. NxtGen scaled slightly from the 2vCPU to 4vCPU machines, while Amazon and Rackspace remained at similar levels. NxtGen recorded significantly lower performance on March 17 for the 2vCPU VM. This may have been caused by a malfunction on the physical host or severe user contention on the storage system.

READ/WRITE WEB SERVER RESULTS



Read/write web servers frequently serve content to viewers and write/update data (such as user subscriptions and user preferences) in databases and/or upload files (such as video or image sharing sites). Examples include blogs, media sharing websites, and social media. The following performance metrics are considered for the read/write web server:

VIRTUAL PROCESSORS | READ IOPS | WRITE IOPS

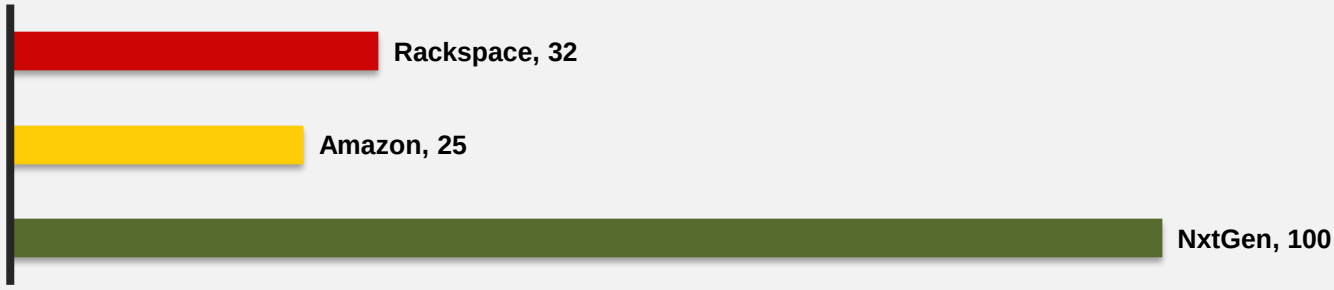
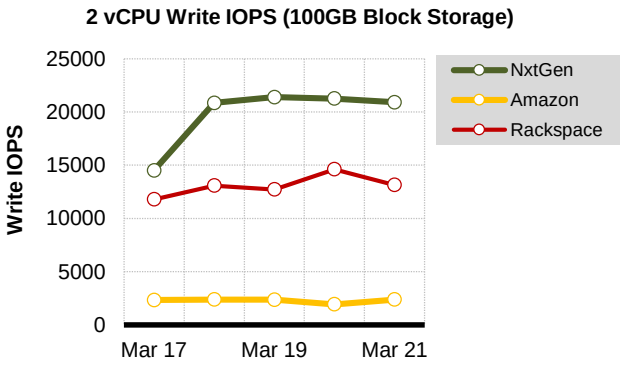
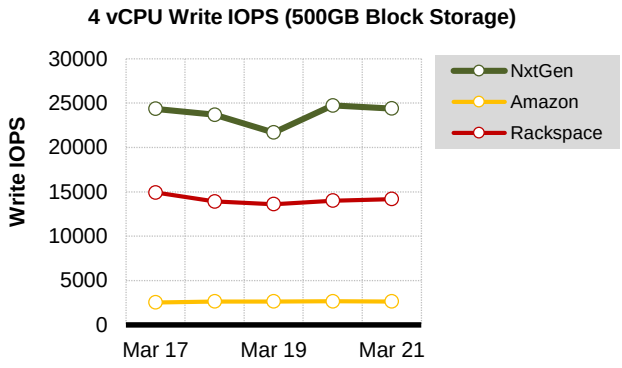


Chart 2: Read/Write web server value analysis included all of the considerations examined in a static web server and included an additional layer of disk write performance. NxtGen ECS VMs highest compared to its counterparts in price-performance value.

Chart 2 illustrates NxtGen ECS VMs demonstrating the highest value for read/write web servers, compared to other providers.

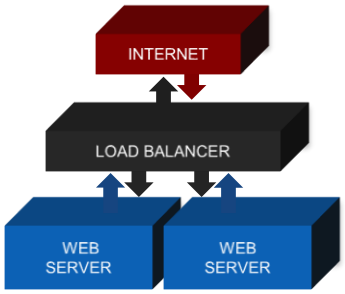
Rackspace's value for read/write web servers is a third the value of NxtGen, due to its higher price for block storage. NxtGen ECS demonstrated the highest write IOPS performance across both the 2vCPU and 4vCPU VMs.





Graph 3: The providers generally exhibited similar performance with the write IOPS as compared to their read IOPS (see Graph 2). The write IOPS results above are comprised of 50% sequential writes and 50% random writes.

HIGH-TRAFFIC WEB SERVER



High-traffic web servers cluster web server environments behind load balancers to leverage horizontal scalability and serve requests to large amounts of incoming users. Examples include large news outlets, travel websites, and e-commerce shops. The following performance metrics are considered for the high-traffic web server:

- VIRTUAL PROCESSORS
- READ IOPS
- WRITE IOPS
- NETWORK THROUGHPUT

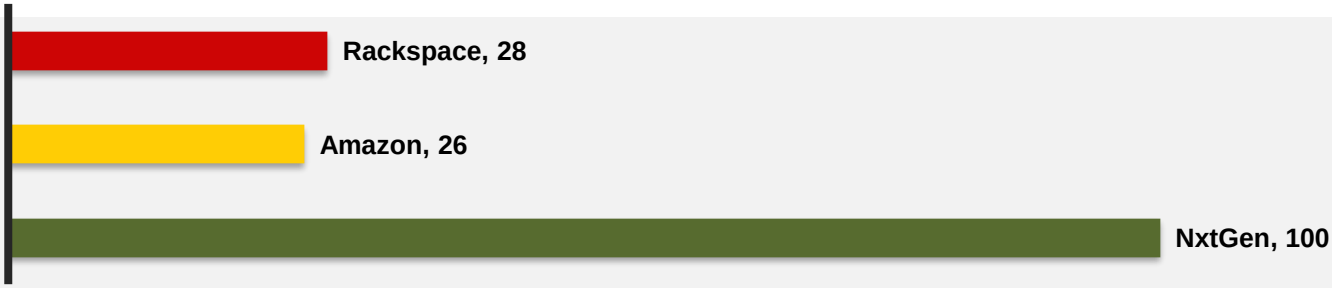
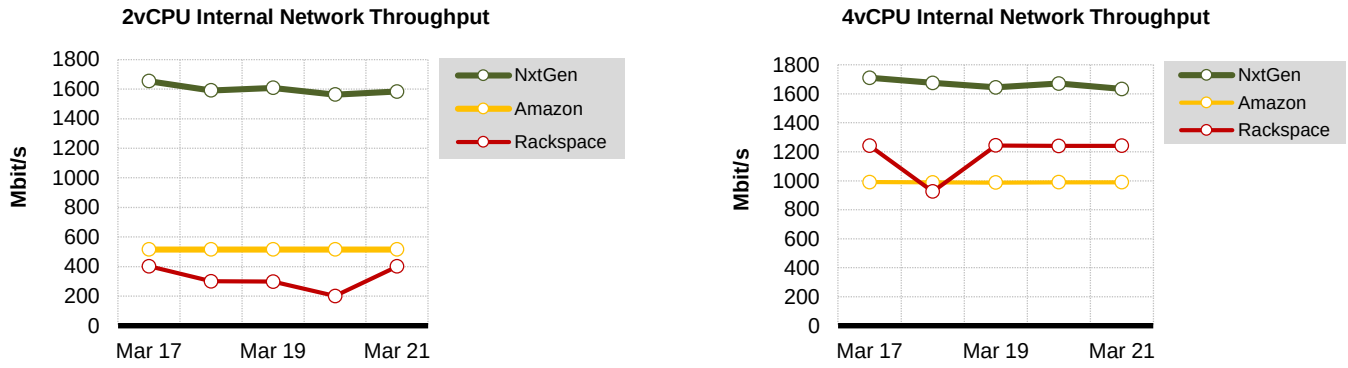


Chart 3: A larger difference in value emerged when examining a scale-out web server environment in the High-traffic Web Server use case. NxtGen ECS VMs scored 1st compared to their counterparts in price-performance value.

NxtGen scored at the top of all tested providers in the composite value score, which included internal network throughput results. Load-balanced web server environments scale by cloning virtual machines to sustain higher traffic and user load. The load balancer(s) then distributed requests among multiple web servers in the environment. When scaling out in a cloud environment, internal network performance in the cluster of VMs can play a major role in the overall performance of that cluster.

Graph 4 shows NxtGen's advantage in network performance, which sustained speeds greater than 1.5GB/s in the study. Both Amazon and Rackspace's network throughput scaled from the 2vCPU to 4vCPU VMs, indicating that network throughput may be throttled according to the server size. NxtGen's static throughput performance across VM sizes suggest that the throughput is not scaled with the size of the VM.



Graph 4: Internal network performance results in this study show NxtGen ECS VMs offer high throughput that does not scale, remaining stagnant between 2 vCPU and 4 vCPU machines.

DATABASES

Apart from the different database applications available, such as MySQL, PostgreSQL, Microsoft SQL, and Oracle, the applicable virtual machine sizes for database environments and numerous use cases can make benchmarking a particular database a very complex process. Cloud Spectator's approach in this study examines the server-side factors involved that affect database performance, namely the processor, memory, disk, and—in the case of large, distributed databases—internal network.

Similar to the web servers, 2 vCPU and 4 vCPU VMs were used in the comparison. For a database, however, it is not uncommon to find large, distributed cluster environments, so 8 vCPU machines were studied as well. Results of the study were separated into two categories: Single-node Database and Clustered Database Environment. Block storage was used for disk testing due to its nature of higher resiliency than local storage.

SINGLE-NODE DATABASE

Single-node databases are small database environments that handle all processing within a single virtual machine. Usually, these types of databases are a piece of a more complex application or environment, such as a LAMP stack for web servers. The following performance metrics are considered for the single-node database:

- VIRTUAL PROCESSORS
- MEMORY BANDWIDTH
- READ IOPS
- WRITE IOPS

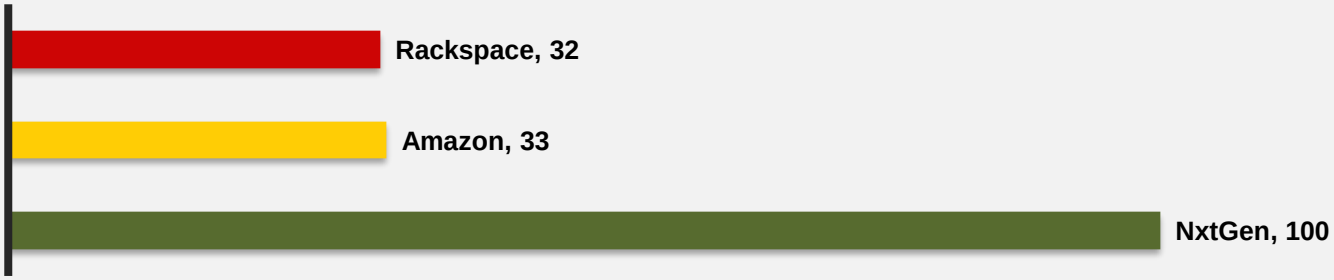
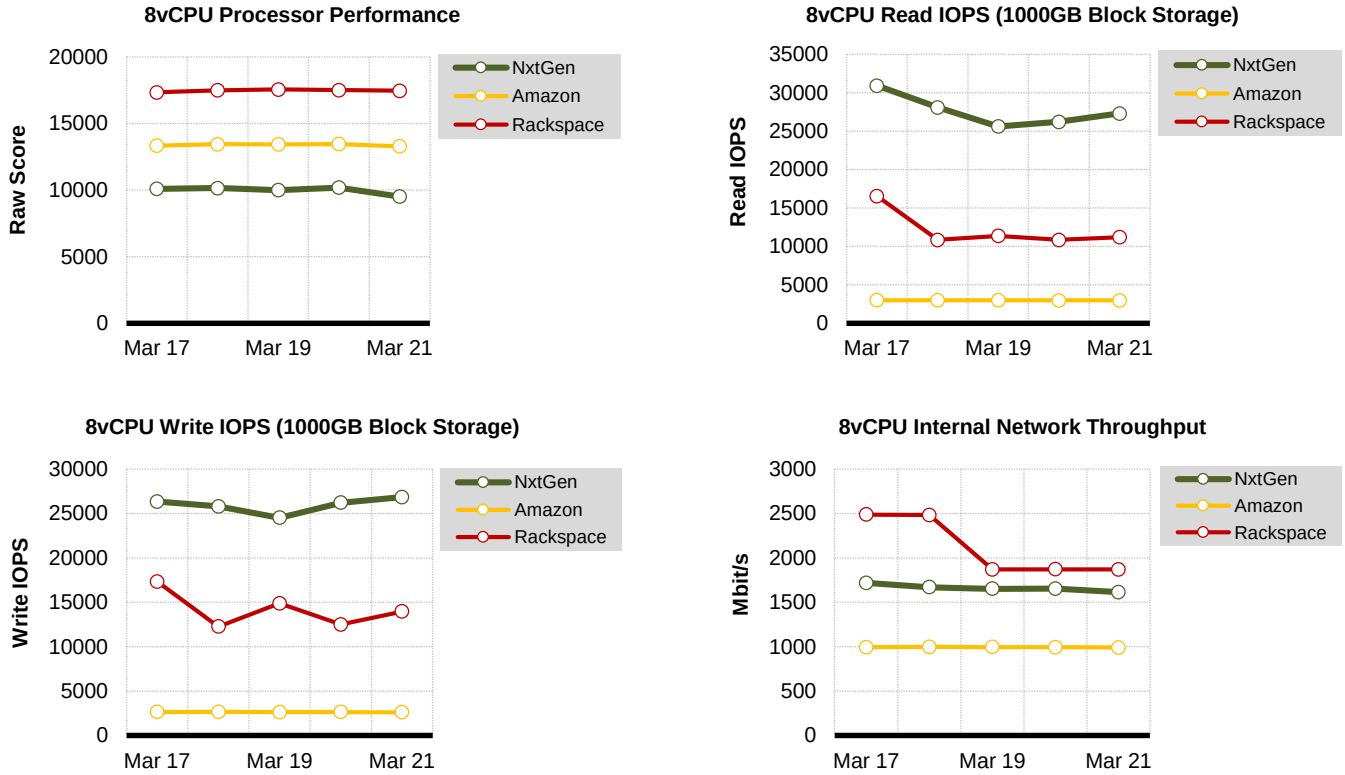


Chart 4: Single-node database performance considers the performance and price-performance value of virtual processors, memory, read and write IOPS. As a collective assessment across 2 vCPU, 4 vCPU, and 8 vCPU VMs, NxtGen produced the most value in price-performance.

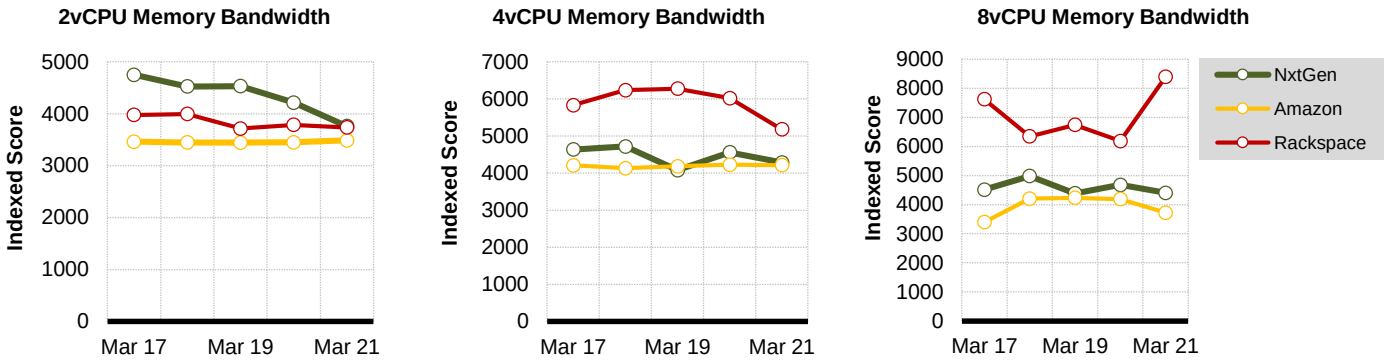
The results of the Single-node Database scenario, which accounted for a variety of server components including the virtual processor, memory, and block storage, were reflective of the overall value concluded by examining 2 vCPU, 4 vCPU, and 8 vCPU VMs on NxtGen ECS, Amazon and Rackspace. NxtGen's value score was the highest for single-node databases.

The block storage results of the 8vCPU VMs compared to the smaller 2vCPU and 4vCPU for the three providers remained roughly the same. The processor scores scaled at varied levels of diminishing returns as the amount of virtual processors increased up to the 8 vCPU machine. While internal network throughput increased with the size of the VM for Rackspace, NxtGen's internal network throughput remained roughly the same as the 2 vCPU and 4 vCPU VMs (see Graph 4).



Graph 5: The graphs above show the performance of the 8 vCPU VMs on NxtGen ECS, Amazon and Rackspace.

For memory bandwidth, NxtGen ECS sustained similar levels of bandwidth across its machines, gaining 2-3% performance when scaling up between VM sizes. As illustrated in Graph 6, Rackspace's memory bandwidth scaled with the VM sizes, outperforming NxtGen and Amazon on the 4vCPU and 8vCPU VMs. The Amazon AWS VMs scaled from the 2vCPU to 4vCPU VMs by 21%, but remain stagnant thereafter.



Graph 6: While memory bandwidth increased between the 2 vCPU and 4 vCPU VMs on all of the providers, there was neglegible change in bandwidth when scaling from the 4 vCPU to the 8 vCPU VMs with the exception of Rackspace. On the 4 vCPU and 8 vCPU VMs, NxtGen ECS scored at similar levels to Amazon, but below Rackspace on the memory bandwidth tests. However, on the 2 vCPU VM, the NxtGen's bandwidth was greater.

CLUSTERED DATABASE ENVIRONMENT

A clustered database environment combines single-node databases into a system acting as a single entity, or cluster. Clustered databases can improve performance and boost resiliency to avoid a single point-of-failure. While the resources that affect single-node database performance translate over to a clustered database environment, another factor, internal network, plays a major role in affecting the cluster's performance as well. The following performance metrics are considered for the clustered database environment:

- VIRTUAL PROCESSORS
- MEMORY BANDWIDTH
- READ IOPS
- WRITE IOPS
- NETWORK THROUGHPUT

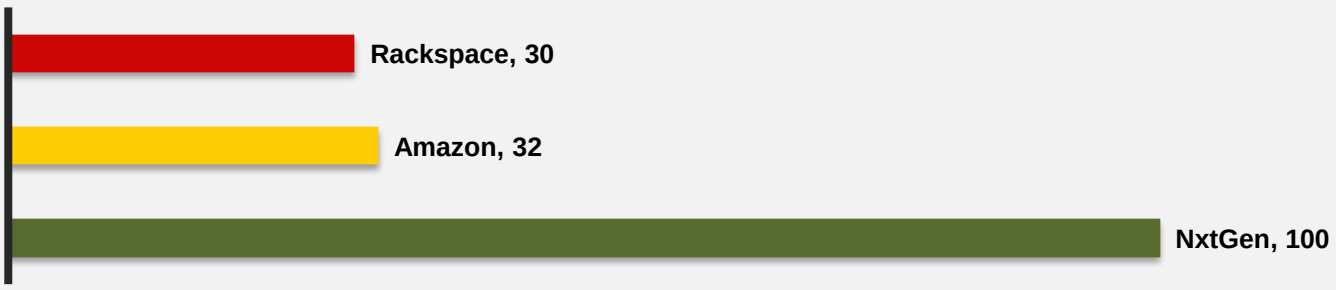


Chart 5: Clustered Database Environments account for performance of all components mentioned and examined in the single-node database environment, but with the addition of internal network performance. NxtGen ECS scored highest out of the three providers.

When factoring in the internal network throughput to consider cluster database environments, NxtGen ECS scored highest for price-performance value compared to its counterparts. NxtGen's internal network throughput, which achieved higher than 1.5GB/s, outperformed throughput from Amazon but performed lower than Rackspace (See Graph 4 and Graph 6).

CONCLUSION

Comparing public cloud offerings on price or features alone does not allow organizations to make fully informed purchase decisions. Organizations should quantitatively assess performance and its relationship with price and related features for smart procurement decisions that optimize the relationship between cost of ownership and quality of service.

In this study, a normalized comparison of major VM components including virtual cores, memory, block storage, and internal network show that NxtGen ECS provides competitive raw performance and strong price-indexed performance for two common applications – webservers and databases.

When comparing virtual machines from NxtGen in the context of the specific use cases examined in the study, NxtGen VMs demonstrated price-performance metrics that were superior to the other providers. NxtGen ECS price-performance scored the highest across the use cases examined in the study, which represents NxtGen ECS's value when examining new vendors for cloud infrastructure.

CONSIDERATIONS & FURTHER STUDY

While this report examines performance relative to web servers and databases, NxtGen ECS's performance and price-performance for virtual processors, memory, block storage and internal network can translate into strong price-performance value for many other applications not examined in this study.

Similarly, as only 2 vCPU, 4 vCPU, and (in the case of databases) 8 vCPU VMs were tested, results should not be assumed to be reflective of performance of any and all cloud or physical servers outside the scope of this study.

For this study, only 100GB, 500GB and 1000GB block storage volumes were used to conduct disk performance tests on read and write IOPS. With providers such as AWS, block storage performance scales with the size of the volume (in the case for AWS, up to 20,000 IOPS per volume for purchasable Provisioned IOPS). Users who are willing to purchase a larger storage volume for greater performance may do so, although the price-performance dynamics will change. The results in this study should not be assumed to represent performance of other instance types or storage volume sizes offered by the selected providers.

About Cloud Spectator

Cloud Spectator leads the industry in performance and pricing analysis for the IaaS marketplace. Since 2011, Cloud Spectator has provided consulting and benchmarking services for enterprise clients, consultancies and providers. Our data-driven approach standardizes and simplifies the IaaS market to inform and guide decision-makers in a complex industry.

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